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Data Assimilation With Regional Lagrangian Models

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LONG-TERM GOALS

The long term goal is regional modeling and data ssimilation, allowing us to test models, and get good estimates of the state of the ocean. These 'inverse' estimates use the data to overcome errors in initial conditions, in boundary conditions, and in dynamical parameterizations.

OBJECTIVES

The objective is to assimilate float or drifter data from both coastal waters and the deep ocean, over a period of at least three months, into a stratified primitive equation model.

APPROACH

Regional primitive equation models are ill-posed, if the domain is Eulerian. However, they are well-posed if the domain is Lagrangian. It is therefore possible to find efficient solutins of the inverse or data assimilation problem in Lagrangian domains, using the methods developed here in the last decade. My postdoctoral fellow Jodi Mead had committed the last 12 months to computing solutions of the inverse problem in a Lagrangian domain together with synthetic data. She will continue work on this project for at least the next 24 months.

WORK COMPLETED

Solutions of the Lagrangian form of the shallow water equations have been compared to solutions of the Eulerian form. Experiments were performed at high resolution on the Connection Machines donated to COAS by ONR. The domain and environmental parameters, etc. correspond to the 1993-1994 North Atlantic Curent project. Good agreement was found between Lagrangian and Eulerian for 1-2 days without friction, and for about 100 days with friction corresponding to a grid Reynolds number of about one.

The Euler-Lagrange equations for variational assimilation with the inviscid Lagrangian model have been derived and implemented using efficient solution strategies.

A presentation of this work was given at the 31st International Liege Colloquium on Ocean Hydrodynamics, and the corresponding paper has been submitted for publication in the Journal of Marine Systems.

RESULTS

We are able to fit the inviscid Lagrangian model with synthetic Lagrangian data for short periods of time (1-2 days). This indicates that real data from floats, such as location and depth, can be assimilated into this model for short time periods.

For longer time periods (100 days), solutions of the Lagrangian model with friction are within 3% of solutions of the Eulerian model, when high resolution numerics are used. This indicates that the Lagrangian model can be used as a reliable basis for assimilation over longer periods.

IMPACT/APPLICATIONS

Not applicable.

RELATED PROJECTS

We are implementing semi-Lagrangian methods to determine if they converse the well-posedness of the open boundary.

REFERENCES

A.F. Bennett and B.S. Chua, 1999: Open boundary conditions for Lagrangian geophysical fluid dynamics, J. Comput. Phys., 153, 418-436.

PUBLICATIONS

J.L. Mead and A.F. Bennett, 1999. Towards regional assimilation of data: The Lagrangian form of the reduced gravity model and its inverse, (submitted), Journal of Marine Systems.